MAGNETIC RECORD OF BJURBOLE METORITE - preliminary report.

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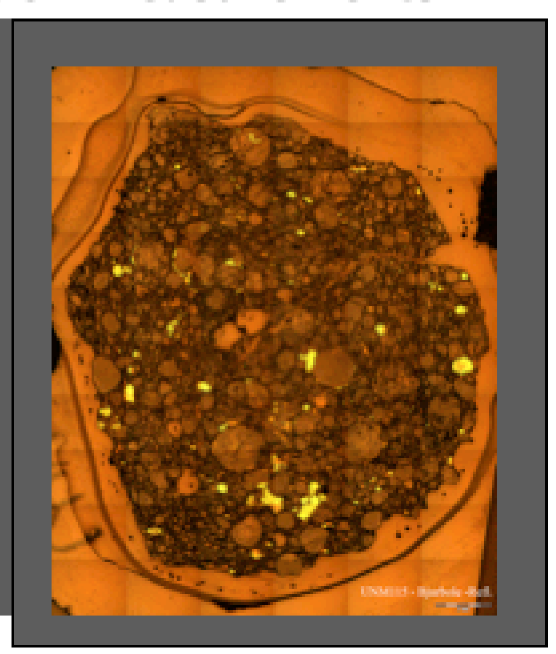
Introduction

Meteorites are the key to unlocking the mystery of the formation and evolution of our solar system. Significant information had been preserved in millimeter or less, sized chondrules embedded in meteorites. Here we present an approach to extract and interpret the information embodied in the magnetic record. Indicators validating magnetic records of meteorites and recognizing contamination have been developed [1]. In addition, we validated the heterogeneity of intensity and orientation. The paleointensity was estimated by applying the empirical scaling law proposed [2].

Method

A precision 3 axis stage enabled the preservation of orientation during extraction of millimeter sized chondrules from meteorite matrix. The stage was attached to a binocular microscope aiding precision during preservation of the orientation. The removed chondrules were transferred to one inch round glass slides for natural remanent magnetization (NRM), isothermal saturation magnetization (SIRM), and demagnetization measurements.

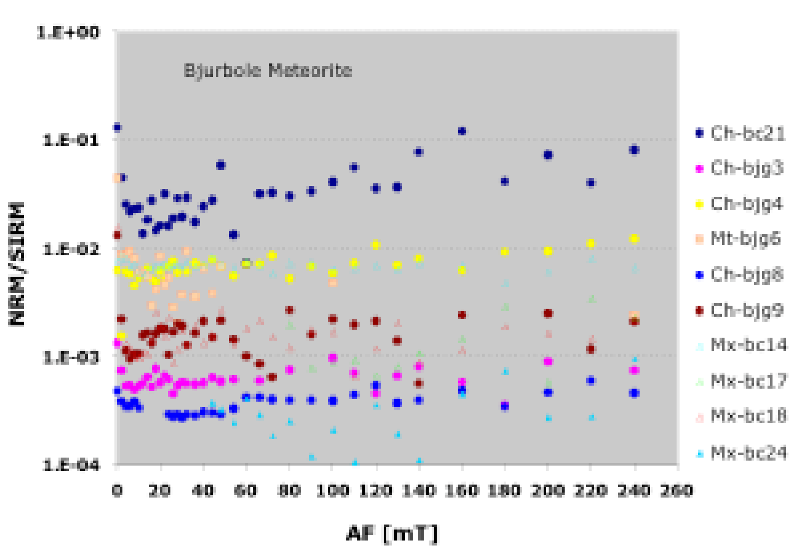
Plate 1: Overview image of the thin section of the Bjurbole meteorite (UNW115), captured by reflected light to see metal grains. About three metal phases are observed and distinguishable by the colors: bright yellow, gold, and orange. Chondrules are well defined



Results

The paleointesity related ratio (NRM/SIRM) (Figure 1) of both chondrules and matrix ranges from 0.0005 to 0.1, and it is indicative of a paleointensity range from 0 to 0.5 mT with no apparent contamination. bc21 chondrule that has >0.01 values interpreted according to the suggested indicators by [1], is also not likely contaminated (stability in small AF). The measured magnetized direction for matrices and chondrules were plotted using the Stereonet produced by [3], and figures 3 show the heterogeneity of the NRM directions. In addition to the REM results, the heterogeneity of directions suggests that the recorded magnetic intensities and directions preserved the initial information acquired during the formation of chondrules or history of aggregation of the meteorite. Hysteresis loops (Figure 2) show larger and smaller coercivities in chondrules and matrix respectively.

Figure 1A: Resulted ratio of NRM to SIRM at room temperature and B: Adopted figure from [6].



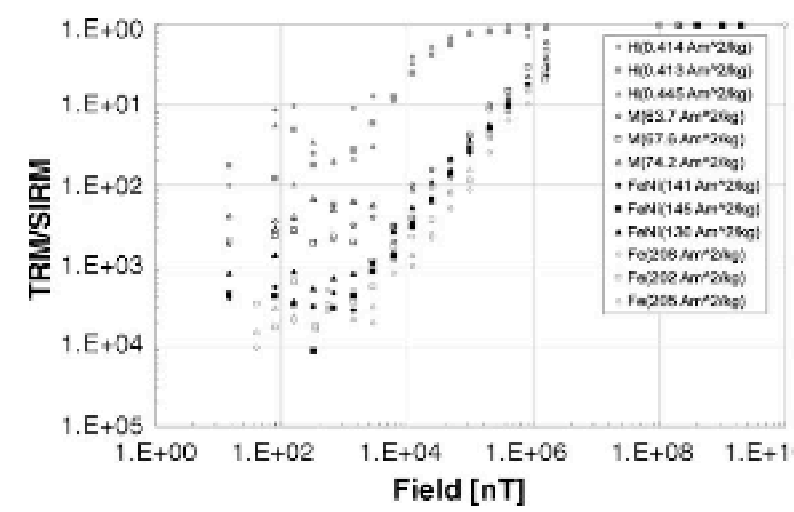
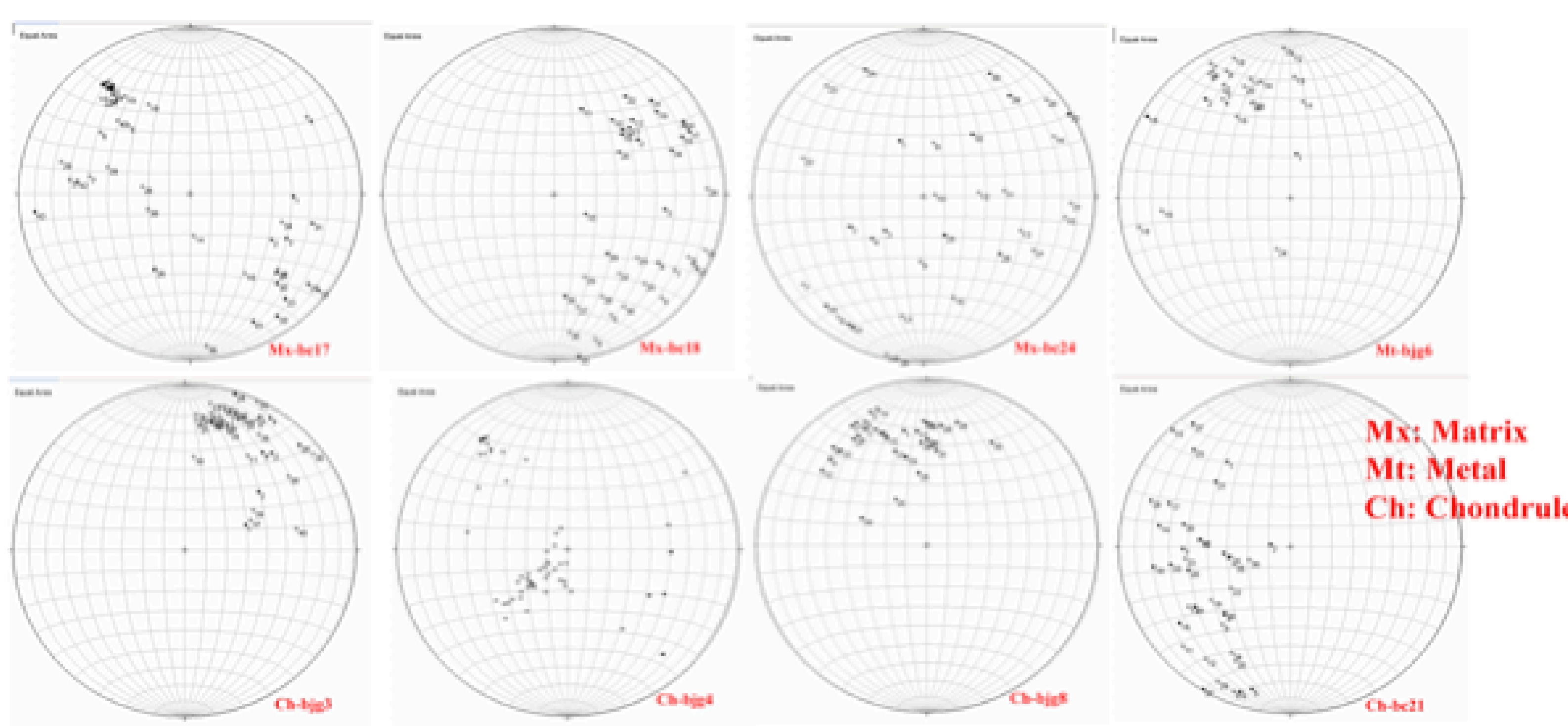


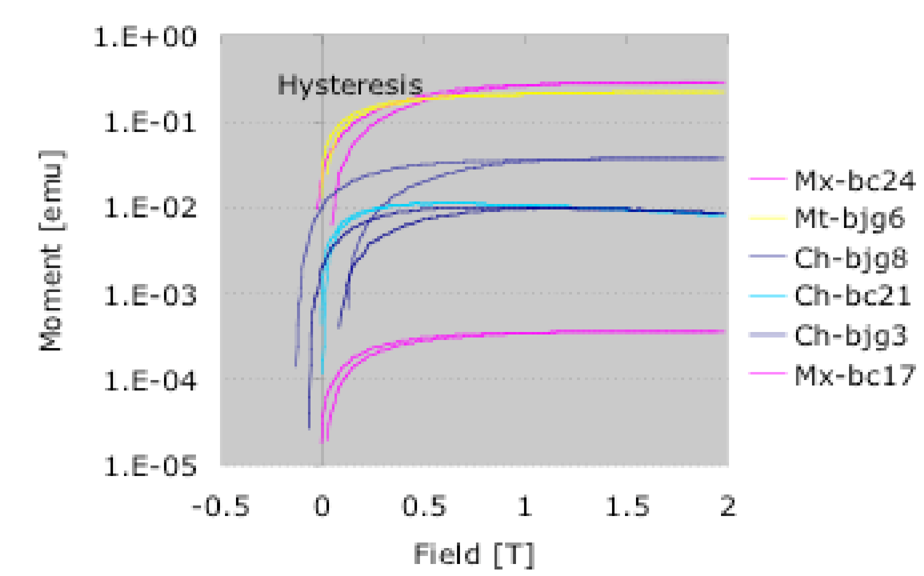
Figure 3: Stereographic projection of the magnetic directions of matrix (bc17 and bc24) and chondrule (bjg3 and bjg4).



Discussion

Large coercivities (Hysteresis loops, Figure 2) and preserved directions (Figure 3) are likely to indicate tetrataenite [4 and 5] as part of the chondrule population. Matrix however has small coercivities and thus contain more likely taenite and kamacite. Matrix magnetic remanence is randomly oriented while demagnetized, however chondrules tend to have stable direction of magnetization. This is indicative of the formation environment. Matrix formed likely in isotropic environment and therefore magnetic signal (if no detectable ambient field present) is scattered. However, chondrules cooled down relatively quickly and the stress involved in volumetric changes caused magnetic mineral elongation and anisotropy leading to enhancement of stability of magnetic directions.

Figure 2: Hysteresis measurement for representative of chondrules, matrix, and metal grain.



References

[1] Wasilewski and Dickinson (2000), Meteortics & Planetary Science 35, 537-544, [2] Kletetschka et al. (2004) Earth & Planetary Science Letters, 226 (3-4), 521-528, [3] Stereonet Windows version (2003) produced by Richard W. Allmandinger, [4] Wasilewski at al. (2002), Meteoritics & Planetary Science, 37, 937-950, [5] Wasilewski (1988), Physics, Earth, Planet. Int. 52, 150-158, [6] Kletetschka et al. (2003) Meteoritics & Planetary Science 38, Nr 3, 399-405.

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